



Validation of the Aura Microwave Limb Sounder Measurements of Stratospheric Water Vapor

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Overview of the Aura MLS v2.10 stratosphere and mesosphere H₂O data product

- ▶ MLS H₂O product is retrieved from observations of the limb emission at 183.3 GHz
- ▶ v2.10 H₂O retrievals have a useful range from 316 – 0.01 hPa
- ▶ Clouds have negligible impact on the stratospheric H₂O product
- ▶ Profiles are retrieved on a pressure grid consisting of 12 levels per decade (spacing ~1.25 km) reducing to 6 levels per decade for pressures < 22 hPa and 3 levels per decade for pressures < 0.1 hPa
- ▶ Vertical resolution (averaging kernel FWHM) is ~4 km
- ▶ Horizontal spacing of profiles is 1.5° great circle arc along the orbit track (~160 km, 24.6 s)

MLS H₂O Retrieval

- ▶ H₂O is retrieved in the 'Core+R2' phase from the MLS R2 190 GHz radiometer bands
 - ▶ band 2 : 25 channel filterbank (1300 MHz bandwidth, 6 MHz band center, 96 MHz band edge)
 - ▶ band 23 : 129 channel digital autocorrelator spectrometer (DACS) (10 MHz bandwidth, 0.15 MHz resolution)
- ▶ Contaminating emission is present due to O₃ (and excited states/isotopes), HNO₃ and N₂O. These species are also retrieved simultaneously from other bands of the R2 radiometer.

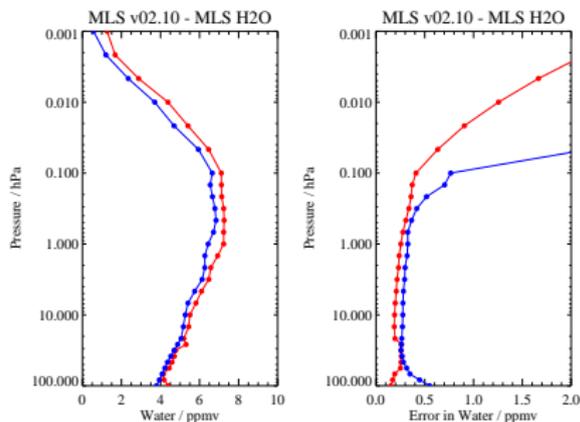
Improvements to the retrieval scheme for v2.10

- ▶ Updated spectroscopy for H₂O and contaminating species (O₃, HNO₃)
- ▶ Increased vertical resolution in the UTLS (12 levels per decade for pressures ≥ 22 hPa)
- ▶ Reduced error inflation (artificial increase of radiance noise to allow for uncertainties in the forward model)
- ▶ Included fine spectral resolution DACS radiances to improve mesospheric H₂O retrievals

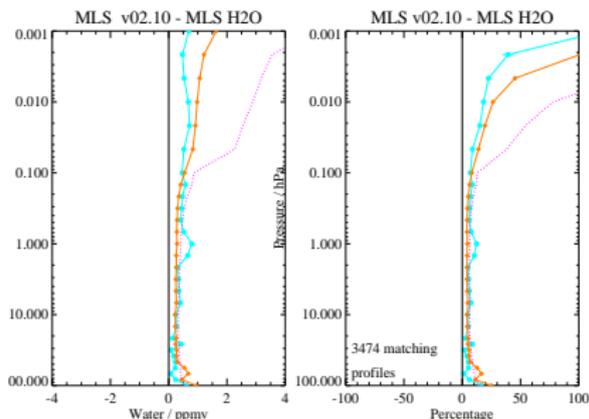
Comparison of MLS v2.10 H₂O with v1.51

28 January 2005

v2.10 H₂O is ~0.5 ppmv larger than v1.51

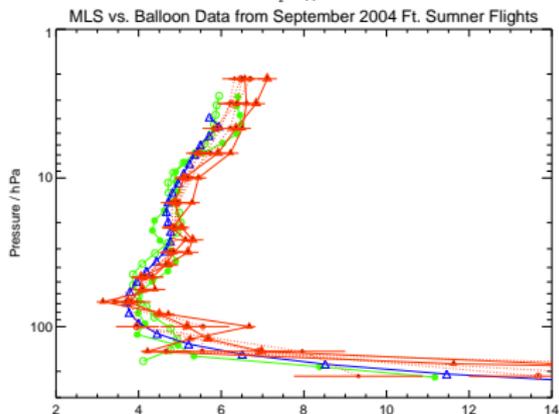
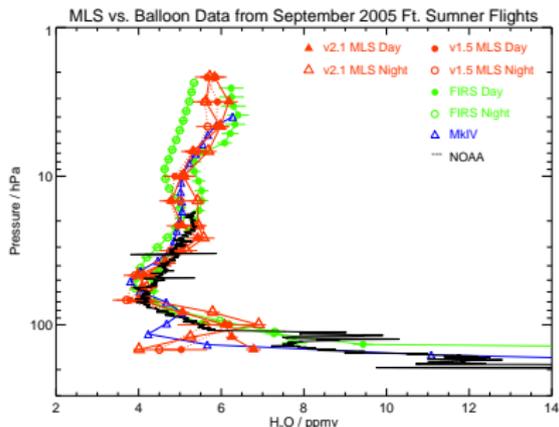


- ▶ Upper panel: Global mean vertical profiles
 - ▶ MLS versions **v2.10** and **v1.51**
 - ▶ Left: Mean vmr profile
 - ▶ Right: RMS precision profile



- ▶ Lower panel: Global mean difference vertical profiles
 - ▶ Left: Statistics of profile differences in vmr units
 - ▶ Mean difference (v2.10 – v1.51)
 - ▶ RMS difference
 - ▶ Expected RMS difference
 - ▶ Right: as Left except shown as a percentage

Comparisons of MLS H₂O with Balloon Measurements



Single profile co-incident MLS retrievals compared to Ft. Sumner Balloon measurements

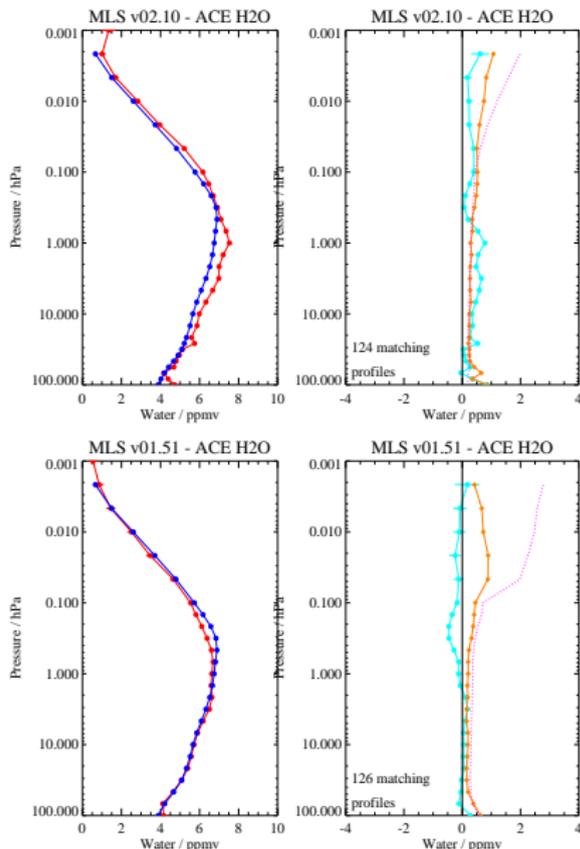
co-incidence selection: closest matching day and night MLS profiles

MLS v1.51 dashed red line, circles
 MLS v2.10 solid red line, triangles

Day: closed symbols
 Night: open symbols

- ▶ Upper panel: September 2005
 - ▶ 20–21 Sep: JPL MkIV, Far Infrared Spectrometer (FIRS-2), Cryogenic Frost-point Hygrometer (NOAA CFH)
- ▶ Lower panel: September 2004
 - ▶ 23–24 Sep: JPL MkIV, Far Infrared Spectrometer (FIRS-2)

Comparisons of MLS H₂O with ACE-FTS



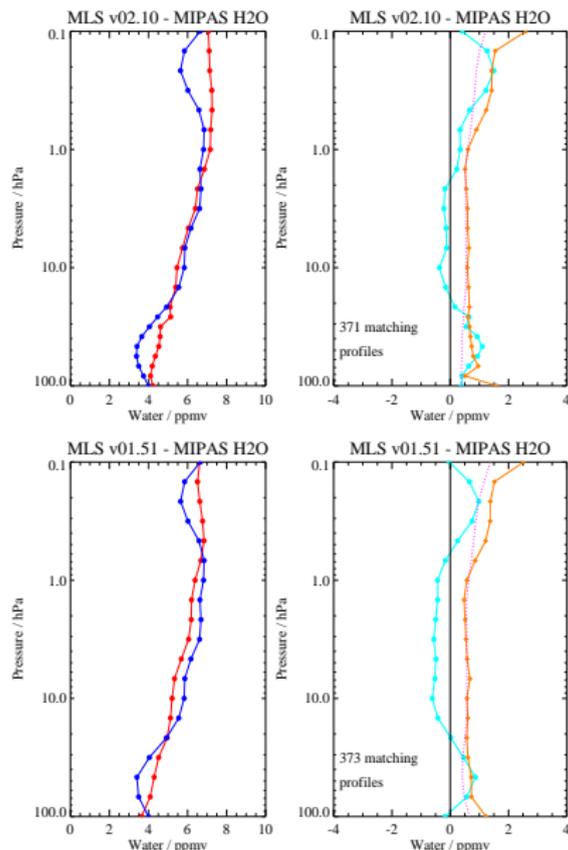
Atmospheric Chemistry Experiment Fourier Transform Spectrometer

17, 23, 24, 25, 29 Sep 2004; 3, 12, 29 Nov 2004; 27, 28 Jan 2005 2, 5 Feb 2005;
4 May 2005; 20, 21 Sep 2005; 22 Jan 2006; 20 Feb 2006

co-incidence window: 1° lat, 4° lon, 12^h time

- ▶ Upper panel: Global mean vertical profiles
 - ▶ **MLS v2.10** and **ACE v2.2**
 - ▶ Left: Mean vmr profiles
 - ▶ Right: Statistics of profile differences in vmr units
 - ▶ Mean difference (MLS – ACE)
 - ▶ RMS difference
 - ▶ Expected RMS difference
- ▶ Lower panel: Global mean vertical profiles
 - ▶ as Upper panel except for **MLS v1.51**

Comparisons of MLS H₂O with MIPAS



Michelson Interferometer for Passive
Atmospheric Sounding

9 orbits on 28 January 2005

University of Oxford off-line retrievals

co-incidence window: 1° lat, 4° lon, 12^h time

► Upper panel: Global mean vertical profiles

- **MLS v2.10** and **MIPAS**
- Left: Mean vmr profiles
- Right: Statistics of profile differences in vmr units
 - Mean difference (MLS – MIPAS)
 - RMS difference
 - Expected RMS difference

► Lower panel: Global mean vertical profiles

- as Upper panel except for **MLS v1.51**

Conclusions

- ▶ MLS v2.10 stratospheric H₂O shows a consistent wet bias of 0.5 ppmv at all altitudes compared to the MLS v1.51 product
- ▶ The estimated precision of MLS v2.10 H₂O is < 0.5 ppmv for pressures > 0.1 hPa
- ▶ A stratospheric wet bias is seen in the comparisons with ACE, however, there is better agreement with MIPAS in the low stratosphere and at the stratopause than the v1.51 data show
- ▶ Vertical oscillations can be seen in the low stratosphere in single profile comparisons
- ▶ Further refinements of the MLS Level-2 H₂O data product will address these issues
- ▶ Release of the MLS v2.2 data products is planned for November 2006